EXPERIMENT 14: WORK AND POWER

PURPOSE:
Understand what Power and Work mean in Physics.

MATERIALS:
stop watch, stairs, measuring tape in inches/feet, bathroom scale.

DATE_____

AUTHOR _____

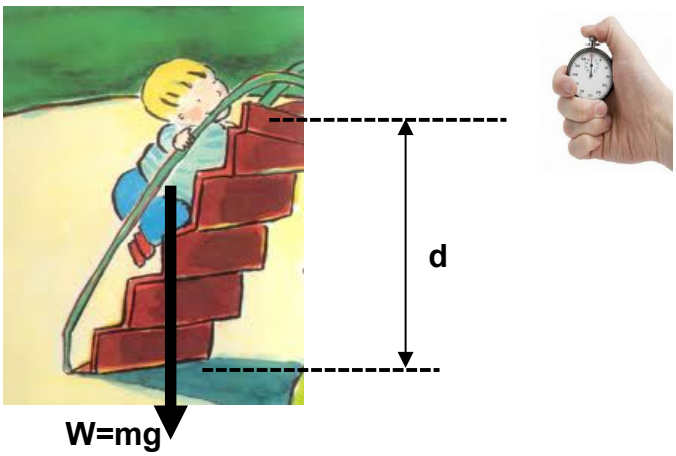
PARTNER _____

PARTNER _____

BACKGROUND

Power is the amount of energy used per unit time. Work is energy in transfer from one system to another. When you walk up the stairs, you are doing work against gravity, the energy stored in your body is transferred to gravitational energy.

The word *work* represents a concept that has a special meaning in science that is somewhat different form your everyday concept of the term. In Science, the concept of work is concerned with the application of a force to an object and the distance the object moves as a result of the force. Work (W) is defined as the magnitude of the applied force (F) multiplied by the distance (d) through which the force acts, **W = F d** .



You are doing work when you walk up a stairway since you are lifting yourself through a distance. (see figure). You are lifting your weight (the force exerted) through the vertical height of the stairs (distance through which the force is exerted). Running up the stairs rather that walking is more tiring because **you use up your energy at a greater rate** when running. The rate at which energy is transformed or the rated at which work is done is called power. **Power** (P) is defined as work (W) per unit time (t).

power = work (energy spent) ÷ time (in seconds)

$$P = W/t$$

If the unit for energy is joules then the unit for power is watt
We can also use the horsepower (hp) as a unit for power.

When the steam engine was first invented there was a need to describe the rate at which engine could do work. Since people at that time were familiar with using horses to do their work, the steam engines were compared to horses. James Watt, who designed a workable steam engine defined **horsepower** (hp) as a power of 550 ft.lb/s. In SI units, power is measured in joules per second, called the **watt** (W). It takes **746 W to equal 1 hp**, and 1kW is equal to about 1 1/3 hp.

PROCEDURE

1. Teams will pick 2 or 3 volunteer to measure the work done, the rate at which work is done, and the horsepower rating as they move up a stairwell. Person A will measure and record the data for person B. Person B will measure and record the data for person A and so forth. An ordinary bathroom scale can be used to measure each person's weight. Record the weight in pounds (lb) in TABLE 1. This weight is the force (F) needed by each person to lift himself or herself up the stairs.

2. The vertical height of the stairs can be found by measuring the height of one step (feet), then multiplying by the number of steps in the stairs. Record this distance (d) in feet(ft) in TABLE 1.

3. Measure and record the time required for each person to *walk normally* up the flight of stairs. Record the time in seconds(s)s in TABLE 1.

4. Measure and record the time required for each person to *run* up the flight of stairs as fast as can be safely accomplished. Record the time in seconds (s) in TABLE 1.

5. Calculate the work accomplished, power level developed, and horsepower of each person while walking and while running up the flights of steps. Be sure to include the correct units when recording the results in TABLE1.

TABLE1 (power = energy/time = force x distance / time)

	Volunteer A		**Volunteer B**		**Volunteer C**	
	Walking	Running	Walking	Running		
Weight (lbs) The weight is a force						
Total vertical height of stairs **(ft)** multiply the height of 1 step by the number of steps.						
Time required (s) to *go up* the flight of steps (stairs).						
Energy lost = **Work done (ft.lbs)** = weight x distance multiply weight by vertical height						
Energy lost per second = **Power (ft.lbs/s)** divide Work by time						
Horsepower (hp) developed divide power y 550						

ANALYSIS

1) How do we define work in Physics ?

2) What is the expression for gravitational potential energy for a mass m located at a position h above the ground on Earth ? (PE=0 @ ground level)

3) If your weight is W and the height to climb is h, what is the expression of the work you are doing on yourself against gravity while climbing ?

4) How do we define power ?

5) 2 persons having the same mass are climbing the same amount of stairs. One is running and the other one is walking.

   Are they both spending the same amount of energy?

   Are they both producing the same amount of power ?

   Explain ?

6) Find out who, in the class, develop the most horsepower. Name : _____
Are you far behind ?

7) Explain why there is a difference in the horsepower developed in walking and running up the flight of stairs.

8) How much of a horse are you ?

For example if hp=0.2 then you can develop 20% of a horse power. So multiply by 100.

CONCLUSION:

You conclusion should include:
- A statement of the goals of the experiment (don't just copy. Use your own words).
- A description of the apparatus and equipment used in the experiments- A brief description of the measurements procedures
- Was the purpose of this lab accomplished ? Why or Why not ? So what did you find out? State the results.
(your answer to this question should show thoughtful analysis and careful, through thinking)
- What are the ways to improve the experiment